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(54) Vibration-cushioned handle

(57) The vibration-cushioned handle, to be clamped in at one end, is designed for an electrical tool or the like. It has a coupling (1) at one end for firm attachment to the body of the tool, and a coaxial handle sleeve (7). At least one cushionec spring element (9) is located between the sleeve (7) and the coupling (1). A handle of this type is intended on the one har to provide good reduction of vibration, and sufficient sturdiness of the handle connection on the other, while being of a simple construction. To this purpose, the spring element (9) has a different spring stiffness in the radial direction relative t the axis of the handle sleeve (7), than in the direction of a pendulous or cardanic excursion of the handle sleeve, around a pole lying on its axis.

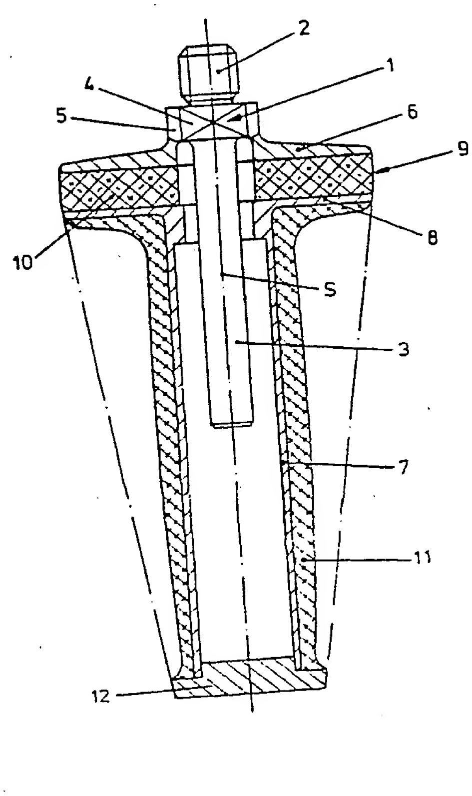


FIG. 1

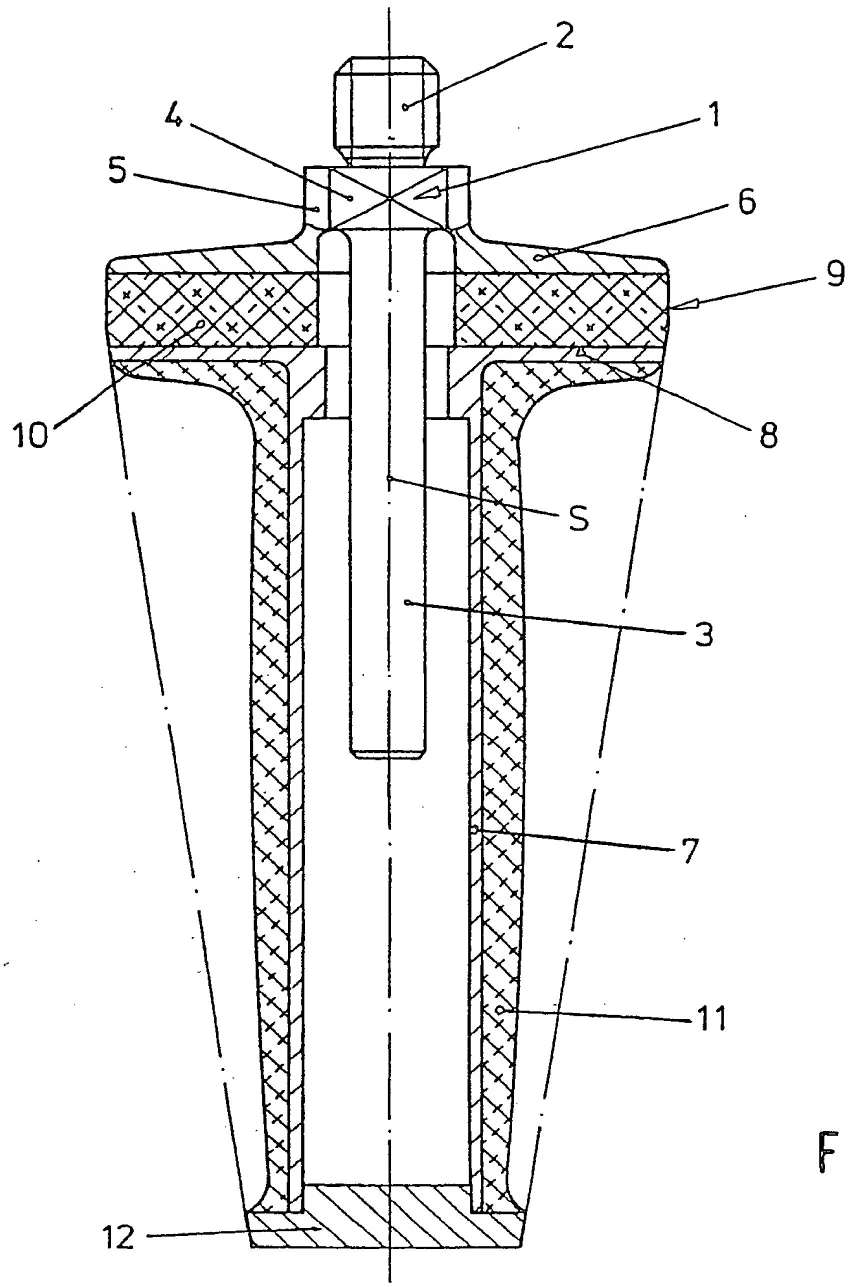


FIG. 1

FIG.2

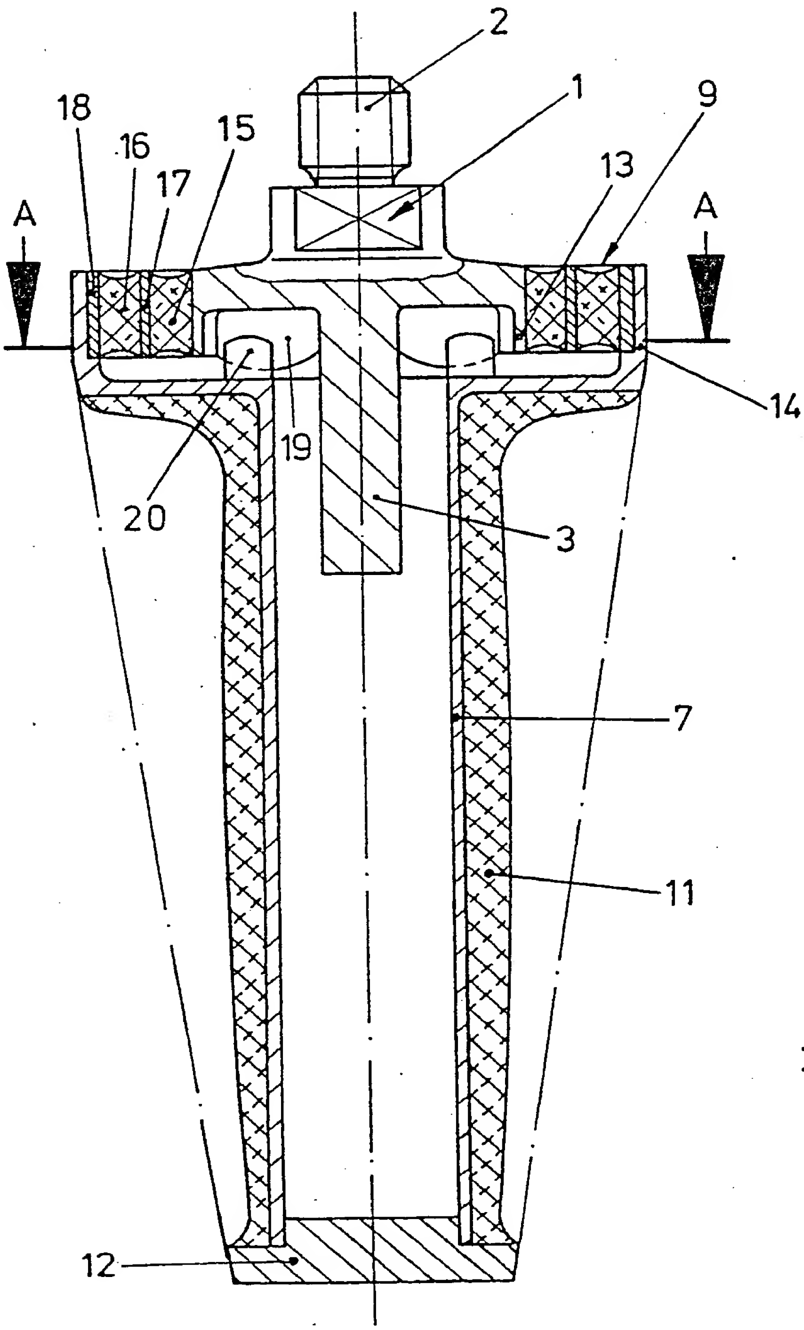


FIG.3

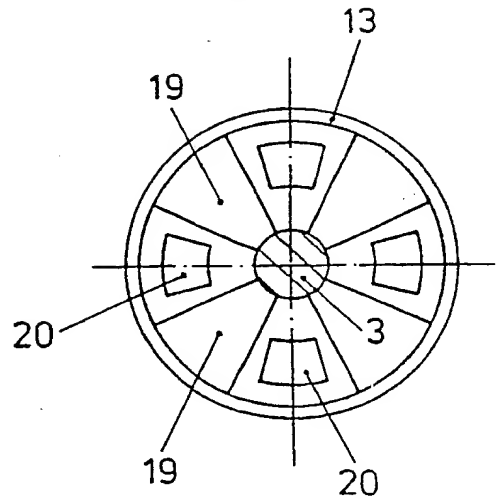


FIG.4

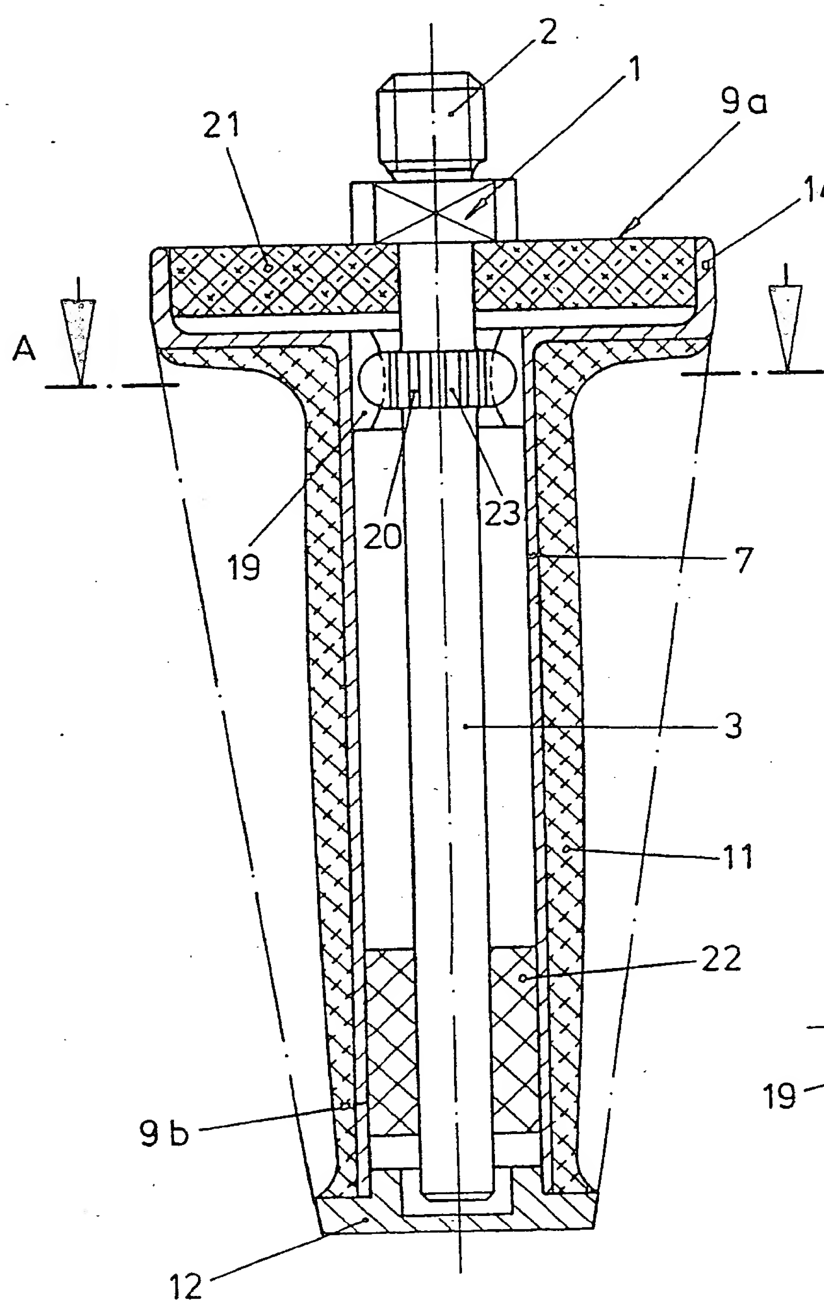
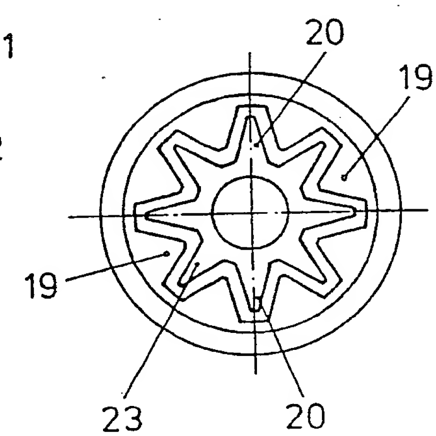


FIG.5



VIBRATION-CUSHIONED HANDLE

The invention concerns a vibration-cushioned handle attachable at one end to an electrical tool or the like.

Such a handle is known from DE 28 04 223 C2; there, rubbery-elastic intermediate pieces in the shape of sleeves are located between a mandrel connected coaxially to the coupling and the handle sleeve of the handle, which should be formed in such a way that, in particular, jolts and vibrations that occur perpendicular to the axis of the body of the handle are cushioned on transfer to the body of the handle and the handle sleeve. The type of vibratory system and the subsequent spring characteristic of the rubbery-elastic intermediate pieces is not discussed in DE 28 04 223 C2.

In DE 31 24 349 A1 there is a description of a handle with vibration cushioning, which has a front vibratory mass body at the handle sleeve close to the coupling, and an end-side vibratory mass body at the free end of the handle sleeve,

both of which are attached to the coupling via elastic connector elements. With this arrangement, the end-side vibratory mass body is connected with the coupling via a first, more rigid connector element, and with the front vibratory mass body via a second, less rigid connector element. In this way, the end-side vibratory mass body is intended to vibrate opposite the front vibratory mass body as a cantilever. The handle sleeve itself serves here as a spring element, which is hinged to the front vibratory mass body, which is connected to the coupling by elastic components, the spring stiffness of which is not described in more detail. The principle of a coupled vibrator is used in this known handle, however, here three spring elements and two additional vibration mass bodies must be adjusted to each other, which is hardly usable in practice.

In accordance with the present invention there is provided a vibration-cushioned handle to be clamped at one end, for a hand electrical tool or the like, with a coupling which can be firmly attached to the housing of the tool, and with a handle sleeve coaxial to the coupling, with at least one cushioned spring element located between the sleeve and the coupling, wherein the spring element has a different spring stiffness on one side in the radial direction relative to the axis of the handle sleeve, compared with the other side in the direction of a pendulous or cardanic excursion of the handle sleeve, around a pole lying on its axis.

In preferred embodiments of the present invention the handle sleeve is joined to the coupling by way of a system

of springs, in which two springs, which may also be unified in a single spring element, as a result of their different spring stiffnesses form a coupled vibrator with two resonance frequencies, between which there is a frequency range in which optimum cushioning takes place. The width of this frequency range, i.e. the cushioning and insulation area, should on the basis of experience, be designed to capture an additional three to five upper frequencies with a significant amplitude for the vibration load, as well as the base excitation frequency. Depending on the respective excitation frequency, the handle mass and the cushioning factors, and taking into account the assessment of hand-arm vibrations with hand tools, the various stiffnesses of the two springs must be selected for the individual case of application, in order to achieve ideal insulation of vibration.

When stating the radial direction of excursion, in which the radial spring stiffness of the spring system is effective, the direction that is referred to is that in which radial displacement takes place between the coupling and the handle sleeve whilst their axes remain parallel. The pendulous or cardanic direction of excursion, in which the cardanic spring stiffness of the spring system takes effect, relates to the movement made by the handle sleeve relative to a pole on its axis. The actual occurring vibrations consist of superimposed vibrations of different direction, the main parts of which are distributed in the two directions described above.

It is of additional benefit if the spring stiffness of the spring system is greater in the radial direction than in the pendulous or cardanic direction of excursion. It is also practical if the spring system in the cardanic direction of excursion has a spring characteristic with a resonance frequency that is lower than the base or excitation frequency transferred from the coupling, whereby the the spring system in the radial direction of excursion has a spring characteristic with a resonance frequency that is at least 2 times higher than that in the cardanic direction of excursion. With conventional, vibratory electrical hand tools or pneumatic hand tools, such as hammer drills or angle grinders, the lower resonance frequency for the spring system in the cardanic direction of excursion should lie below the base or excitation frequency by a factor of at least 1.4.

In order to achieve the different spring stiffness in the radial direction of excursion on the one hand, and in the cardanic direction of excursion on the other, one can either design the spring system with one or several spring components of the same or differing spring stiffness arranged one behind the other in the radial direction, or with two part spring components which are arranged separated from each other in the axial direction. In the latter case, it is beneficial to put the first part spring close to the clamping point, and a second part spring close to the free end of the handle sleeve, with the first part

spring having a lower spring stiffness than the second part spring. In this way, one obtains a higher resulting spring stiffness in the radial direction of excursion, since in this direction, the spring characteristics of both part springs are added. In the cardanic direction of excursion, however, the spring characteristic is low due to the weaker spring stiffness of the first part spring.

An enhanced design uses spring elements made of rubber or rubbery-elastic material, in order that the spring and cushioning characteristics respectively can be unified in a single element. The stiffness and the cushioning properties can be varied widely by a rubber spring, and can be influenced both by the geometrical shape as well as the properties of the rubber, particularly hardness, thus permitting easy adaptation to the various cases of application.

Certain embodiments of the invention will now be described, by way of example only, with reference to the drawings, in which:

Fig. 1 a longitudinal section through a handle conforming to the first embodiment;

Fig. 2 a longitudinal section through a handle conforming to the second embodiment;

Fig. 3 a cross section through the handle, along line A-A in fig. 2;

Fig. 4 a longitudinal section through a handle conforming to the third embodiment;

Fig. 5 a cross section along line A-A in fig. 4;

In detail, fig. 1 shows a handle with a coupling 1, which is firmly connected to the housing of an electrical hand tool or the like. The coupling 1 has a thread base 2, which can be screwed into a threaded hole in the machine housing. Coaxially to the thread base 2, the coupling has a mandrel 3. Between the mandrel 3 and the thread base 2 on the coupling 1 is located a multi-edge section 4, on which a sleeve 5 is pressed. The sleeve 5 is single part with a radial flange 6, which on the side facing the thread base 2 has a plane connection surface in the radial direction.

Located coaxially to the coupling 1 is a handle sleeve 7 or a handle body, which is at least partly penetrated by the mandrel 3 of the coupling 1. The handle sleeve 7 also has a radial flange 8 at the end facing the clamping point, which lies coaxially opposite at a distance from the radial flange 6 of the coupling, and has a plane radial connection surface. Both radial flanges 6 and 8 also have the same diameter, and accommodate a spring element 9 between them.

The spring element 9 has, in the example shown in fig. 1, the form of a spring washer 10, which is made of rubber material and is joined firmly to the connection surfaces of the radial flanges 6 and 8 of the coupling 1 and the handle sleeve 7 by vulcanizing. Consequently, the spring washer 10 can also transfer thrust forces which are directed in from the radial flanges 6 and 8, parallel to the respective connection surfaces. In the effective direction of these forces, i.e. in the radial direction to the coupling 1 and the handle sleeve 7, the spring washer 10 has a different, higher stiffness than in the cardanic direction. The spring washer 10 thus unifies two springs in itself, with one spring acting in the radial direction and the other in the axial direction. The spring washer 10 is acted on primarily by vibratory components of the coupling 1 lying perpendicular to the axial direction, whereby the spring washer is displaced, compressed or stretched. The weaker cardanic spring stiffness results from the compression and streching of the spring washer 10 on two diametrically opposing points. As a result, the handle sleeve 7 performs cardanic movements against the coupling 1, making pendulous movements around a pole S lying on their axis.

Due to the differing spring characteristics of the spring washer 10, and thus also the spring element 9, the handle sleeve 7 is connected to the coupling 1 by way of a cushioned, coupled vibrator, whereby the resonance frequency of the spring washer 10 in the direction of cardanic spring stiffness is selected at a factor of around

1.4 below the excitation base frequency of the coupling 1, and the resonance frequency of radial spring stiffness of the spring washer above the disturbing upper vibrations of the base frequency. In preferred embodiments it is practical to have the upper resonance frequency being at least twice the lower resonance frequency. Between these two resonance frequencies there is a frequency range in which the handle sleeve 7 experiences optimum vibration cushioning against the coupling 1.

The cushioning of vibration can be enhanced by a coating 11 on the handle sleeve 7, made of rubber or a rubbery-elastic material. The handle coating 11 should be ergonomically shaped so as to be comfortably held by a human hand, and its rubbery-elastic material offers on the one hand good cushioning in the resonance range of the vibratory system, and guarantees on the other hand the greatest possible insulation from vibration. In preferred embodiments, in order to accommodate all demands made of it, one should select the handle coating 11 with Shore hardness ratings of 40 to 75 Shore A, in order that the haptic properties are also enhanced. If the coating is thick enough, this relatively soft material can offer compensation and adaptation to the anatomically different hand sizes of persons operating the equipment, and above all, a handle coating of this type also insulates the unpleasant high frequency vibrations.

The handle sleeve 7 is closed at its free end by a plug 12, which on the one hand presents an additional mass, and on

the other hand assists towards the soft handle coating 11 not being able to be damaged or destroyed at the end face side of the handle sleeve 7, particularly when the machine to which the handle is fitted is put down.

The embodiment shown in Fig. 2 differs from that shown in fig. 1, in having a different form of spring element 9, which here is located between a band 13 on the coupling 1, which goes around the circumference, and a collar 14 on the handle sleeve 7 which is around this band 13 with a space. The spring element 9 consists of several spring sections 15 and 16, which lie one behind the other in a radial direction and are enclosed by coaxial intermediate sleeves 17 and 18. Collectively, this forms a rubber sleeve spring 15 - 18, with which, in comparison with the rubber spring according to the embodiment of fig. 1, and with the same geometric dimensions, lower cardanic spring stiffness and higher radial (thrust) rigidities can be implemented. Here, particularly, the radial spring stiffness can be increased further with the existing geometric conditions by using one or more intermediate sleeves 17 and 18 and appropriate sectioning of the rubber sleeve springs in spring sections 15 and 16, without any noticeable influence on the cardanic spring stiffness.

With this version also, the handle behaves as a coupled vibrator, since it has an identical degree of freedom as the embodiment shown in fig. 1, and both main vibrations, namely those in the

radial and the cardanic direction of excursion, are coupled with each other.

To protect against impermissible torsion stress with this version, dogs 19 are fitted to the coupling, and opposing dogs 20 to the handle sleeve 7, and are engaged with play on all sides, as shown in fig. 3, in order to prevent a positive connection which would obstruct the compensation of vibration. Only with over-proportionally high radial and lateral forces will the dogs 19 and opposing dogs 20 impact with each other, but forces of this extreme can be taken account of by mandrel 3 contacting the inner side of the handle sleeve 7.

The embodiments shown in fig. 4 and fig. 5 show another version of the dogs 19 and opposing dogs 20, whereby the dogs 20 here are arranged on a radially protruding band 23, somewhat in the shape of a cog, located on the mandrel 3 of the coupling 1.

The embodiment shown in fig. 4 shows a further design of the spring element 9, which here is divided into one spring part 9a located close to the clamping point, and a second spring part 9b located close to the free end of the handle sleeve 7. The first spring part 9a is formed by a rubber sleeve spring 21, the radial extent of which is greater than the axial extent which achieves a lower radial spring stiffness than that of the second spring element 9b. The second spring element 9b is also a rubber sleeve spring 22,

the radial extent of which, however, is smaller than the axial extent, resulting in the relatively high radial spring stiffness. The two rubber sleeve springs 21 and 22 are located directly on the mandrel 3 of the coupling 1 on the one side, and support themselves on the other side directly on the handle sleeve 7, which in this embodiment has a collar with a wider diameter in the region of the clamping point, in order to accommodate the rubber sleeve spring 21, which is longer in the radial direction than in the axial direction, close to the clamping point.

At least in its preferred embodiments the present invention provides a vibration-cushioned handle which, while having a simple construction, offers good vibration reduction on the one hand, and sufficient sturdiness of the handle coupling on the other.

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Claims

1. Vibration-cushioned handle attachable at one end to a hand tool comprising a coupling which can be firmly attached to the housing of the tool, a handle sleeve coaxial to the coupling, and at least one one cushioned spring element located between the sleeve and the coupling, wherein the spring element has a different spring stiffness in the radial direction relative to the axis of the handle sleeve compared with the spring stiffness in the direction of a pendulous or cardanic excursion of the handle sleeve, around a pole lying on its axis.

2. A handle according to claim 1, wherein the spring stiffness of the spring element is higher in the radial direction than in the direction of pendulous or cardanic excursion.

3. A handle according to claim 2, wherein the spring element has, in the direction of cardanic excursion, a spring characteristic with a resonance frequency which is higher than the excitation frequency transferred from the coupling.

4. A handle according to claim 3, wherein the spring element has, in the direction of radial excursion, a spring characteristic with a resonance frequency which is at least 2 times as high as in the direction of cardanic excursion.

5. A handle according to one of claims 1-4, wherein the spring element consists of two or more spring members of the same or differing spring stiffness located one behind the other in the radial direction.

6. A handle according to one of claims 1-5, wherein the spring element is located near a point of attachment of the handle.

7. A handle according to one of claims 1-4, wherein the spring element consists of two-part springs which are located separately from each other in the axial direction of the handle sleeve.

8. A handle according to claim 7, wherein the first spring part is located near to the point of attachment of the handle, and the second spring part is located close to a free end of the handle sleeve.

9. A handle according to claim 8, wherein the first spring part has a lower radial spring stiffness, and the second spring part a higher radial spring stiffness.

10. A handle according to one of claims 1-9, wherein the spring element is made of rubber or a rubbery-elastic material.

11. A handle according to claim 10, wherein coaxially opposing radial flanges are located on the coupling and on the inner end of the handle sleeve, between which a spring washer is located made of rubber material which has been vulcanized.

12. A handle according to claim 10, wherein a band is located on the coupling in the direction of the circumference and the handle sleeve has a collar spaced around the band, with a spring rubber sleeve being located between the band and the collar.

13. A handle according to claim 12, wherein the rubber sleeve spring is subdivided in the radial direction into two or more spring sections by one or more coaxial

intermediate sleeves.

14. A handle according to claim 10, wherein the coupling has a mandrel stretching coaxially through the handle sleeve, whereby the collar of the handle sleeve has a widened diameter at the end facing the point of attachment of the handle, an initial rubber sleeve spring being located between the collar of the handle sleeve and the mandrel, the radial extent of which is greater than the axial extent, and a second rubber sleeve spring being located close to the free end of the handle between the handle sleeve and the mandrel, the radial extent of which is smaller than the axial extent.

15. A handle according to claim 1-14, wherein an additional mass is located at the free end of the handle sleeve.

16. A handle according to claim 15, wherein the additional mass is formed by a closure plug in the handle sleeve.

17. A handle according to one of claims 1-16, wherein the handle sleeve has a coating made of a rubbery elastic material.

18. A handle according to one of claims 1-17, wherein at least one dog and opposing dog are located on the coupling and the handle sleeve respectively as anti-twist elements and are engaged with each other with play on all sides.

19. A handle substantially as hereinbefore described with reference to Figure 1 of the drawings.

20. A handle substantially as hereinbefore described with reference to Figures 2 and 3 the drawings.

21. A handle substantially as hereinbefore described with reference to Figures 4 and 5 of the drawings.

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